MASTER OF TECHNOLOGY IN

Biotechnology

CURRICULUM & SYLLABUS

Semester I

Code	Course Title	Contact Hrs./	Credit
A	Theory	L	
		3-1-0	4
MBT - 101	Genetic Engineering (Core Subject)		
MBT - 102	Project Management	3-1-0	4
MBT - 103	Advanced Plant Biotechnology /Plant Genetic Engineering (Core Subject)	3-1-0	4
MBT - 104	Numerical Analysis and Biostatistics / Mathematics and Biostatistics	3-1-0	4
MBT - 115 (A/B/C/D/E)	Elective-I	3-1-0	4
		15-5-0	20
B	Practical		
MBT - 191	Genetic Engineering Lab	0-0-6	2
MBT - 192	Advanced Plant Biotechnology Laboratory / Enzyme Technology Lab	0-0-6	2
		0-0-12	4
MBT-193	Seminar I	0-0-3	1
	Semester Total	15-8-12	25

Elective-I

Code	Course Title	Contact Hrs./ Wk	Credit
MBT – 115A	Genomics & Proteomics	3-1-0	4
MBT – 115B	Advanced Biochemistry	3-1-0	4
MBT – 115C	Bio-entrepreneurship and Management	3-1-0	4
MBT - 115D	Advances in Bioreactor Design, Development and Scale up	3-1-0	4
MBT – 115E	Biophysical Chemistry	3-1-0	4

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Semester: II

Code	Course Title	Contact Hrs./ Wk	Credit
A	**Theory**	**L-T-P**	
MBT -201	**Advanced Bioinformatics (Core Subject)**	**3-1-0**	**4**
MBT -202	**Immunology (Core Subject)**	**3-1-0**	**4**
MBT -203(A/B)	**Bioprocess Engineering & Technology / Bio-processing Technology**	**3-1-0**	**4**
MBT -204	**Downstream Processing**	**3-1-0**	**4**
MBT - 215 (A/B/C/D/E/F/G)	**Elective-II**	**3-1-0**	**4**
		15-5-0	**20**
B	**Practical**		
MBT - 291	**Bioinformatics Laboratory**	**0-0-6**	**2**
MBT – 292(A/B/C)	**Downstream processing Lab/ Immunology Lab / Animal Cell Culture Laboratory**	**0-0-6**	**2**
		0-0-12	**4**
MBT-294	**Seminar II**	**0-0-3**	**1**
	Semester Total	**15-7-12**	**29**

Elective-II

Code	Course Title	Contact Hrs./ Wk	Credit
MBT - 215A	**Animal Cell Culture and it's application**	**3-1-0**	**4**
MBT – 215B	**Nano Biotechnology**	**3-1-0**	**4**
MBT – 215C	**Teaching Methodology in Technical Educationn nn**	**3-1-0**	**4**
MBT - 215D	**Genomics & Proteomics**	**3-1-0**	**4**
MBT – 215E	**Genetics & Cell Biology**	**3-1-0**	**4**
MBT – 215F	**Bio-entrepreneurship and Management**	**3-1-0**	**4**
MBT – 215G	**Agriculture Biotechnology**	**3-1-0**	**4**
MBT – 215H	**Cell Biology**	**3-1-0**	**4**

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Semester: III

Code	Course Title	Contact Hrs./ Wk	Credit
A	**Theory**	**L-T-P**	
MBT – 315 (A/B/C/D)	**Elective-III**	**3-1-0**	**4**
MBT – 316 (A/B/C/D)	**Elective-IV**	**3-1-0**	**4**
		6-2-0	**8**
B	**Sessional**		
MBT - 391	**Thesis -Part I (Presentation and Viva)**	**-**	**15**
	Semester Total	**6-2-0**	**23**

Elective-III

Code	Course Title	Contact Hrs./ Wk	Credit
MBT - 315 A	**Research Methodology and Technical Report Writing**	**3-1-0**	**4**
MBT - 315 B	**Nanotechnology**	**3-1-0**	**4**
MBT – 315 C	**Modeling and Simulation in Bioprocess**	**3-1-0**	**4**
MBT – 315 D	**Pharmaceutical Biotechnology**	**3-1-0**	**4**

Elective-IV

Code	Course Title	Contact Hrs./ Wk	Credit
MBT - 316 A	**Biosafety, Ethics and IPR**	**3-1-0**	**4**
MBT - 316 B	**Environmental Biotechnology**	**3-1-0**	**4**
MBT – 316 C	**Bio pharmaceuticals**	**3-1-0**	**4**
MBT – 316 D	**Advanced Instrumentation in Biotechnology**	**3-1-0**	**4**

Semester: IV

Code	Course Title	Contact Hrs./ Wk	Credit
B	**Sessional**		
MBT - 491	**Thesis-Part II (Report and Presentation)**	**0-0-0**	**20**
MBT - 492	**Project Viva/ Thesis Viva**	**0-0-0**	**5**
MBT-481	**Comprehensive viva voce**	**-**	**3**
	Semester Total	**0-0-0**	**28**

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Semester: I

MBT-101: Genetic Engineering (Credit 4) Unit I Basics tools of

Genetic Engineering

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions- Electromobility shift assay; DNaseI footprinting; Methyl interference assay; Chemical Synthesis of oligonucleotides.

Unit II Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-can be omitted vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system.

Unit III Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression.

Unit IV PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test), Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing.

Unit V Applications of Genetic Engineering

Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. J. D. Watson et al.; Recombinat DNA, W.H. Freeman and Company
4. B. R. Glick and J.J. Pasternak ; Mlecular Biotecnology: Principles and Applications of Recombinant DNA, ASM press
5. D. M. Glover and B.D. Hames; DNA cloning: A Practical Approach, IRL Press.
6. Brown TA, Genomes, 3rd ed. Garland Science 2006
7. Selected papers from scientific journals.
8. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

MBT 102 - Project Management (Credit 4)

Unit I
Project Planning: Project Management scenario: Project Asset – issues and problems; Gantt Chart & LOB; Network Analysis; PERT/ CPM, Resource Monitoring& Control.

Unit II
Project Buying: Projects Procurement Process, Life-cycle costing, Project cost reduction methods, Project Stores, Organization & HRD issues, Computerization.

Unit III
Investment Feasibility Studies : Managing Project Resources Flow; Project cost- Capital & Operating; Forecasting Income, Estimation of Investment & ROI, Project Evaluation, Finance Sources, Appraisal Process.

Unit IV
Issues in Project Management: Project Audit, Project Monitoring& MIS, Cost Control, Real Time planning, Intangibles.

Unit V
Project Management: Case Studies.

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MBT – 103: Advanced Plant Biotechnology (Credit 4) Unit I Plant Tissue Culture: An

overview

Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Unit II Plant Genomics

Identification of candidate genes using: genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics); **Characterization and functional analysis of candidate genes using**: transformation, mutant populations, knockout systems; Heterologous expression systems; Protein analysis.

Unit III The Gene transfer Techniques for the production of Transgenic

Overview of different gene transfer methods

- **Indirect Gene transfer Methods:** structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in Agrobacterium mediated gene transfer.
- **Direct gene transfer methods:** Particle bombardment mediated transformation, Mechanism, Particle gun design, parameter for effective transformation; selicon carbide fiber mediated transformation and alternative methods.
- Reporter genes, Selectable and scorable markers, Binary and Co-integrative vectors, Removal of marker genes, Applications and limitations of Agrobacterium gene transfer.
- Plastid engineering: Introduction, importance, scope and technique.

Unit IV Application of Genetic Engineering: Some Case studies

Genetic Engineering for Herbicide resistance

- Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance
- Genetic Engineering for Vitamins and other value addition compounds
- Genetic Engineering for Production of pharmaceutically important compounds
- Genetic Engineering for Bioenergy generation
- Terminator technology

Unit V Gene Silencing and Signal Transduction

An overview: RNA virus in plants, virus induced gene silencing and its application; Plant receptors, G protein and phospholipids signaling; cyclic nucleotides, Role of Calcium in signaling, Protein kinases as primary elements in signaling; Particular pathways of signal transduction associated with plant growth regulators.

Texts/References:

1. SS Bhojwani & MK Razdan. *Plant Tissue Culture: Theory and Practice, a Revised Edition.* 2005. Elsvier
2. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press,2008

3. HS Chawla. Introduction to plant Biotechnology,2nd Edition, Oxford & IBH,2002
4. Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones**.** Biochemistry & Molecular Biology of Plants, ASPB Publication, 2008
5. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
6. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
7. R J Henry, Plant Genotyping: The DNA Fingerprinting of Plants, CABI Publication, 2001

MBT – 103: Advanced Plant Biotechnology (Credit 4)

Unit I Plant Genomics and Molecular Mapping

1. Introductory lecture.
2. Identification of candidate genes using: genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics).
3. Characterization and functional analysis of candidate genes using: transformation, mutant populations, knockout systems; Heterologous expression systems.
4. Structural and Functional genomics; application of sequence based and structure- based approaches to assignment of gene function.
5. Constructing molecular maps; Molecular tagging of genes/traits; Marker assisted selection of qualitative and quantitative traits.
6. Molecular marker technology; map-based cloning and their use in transgenics. MAS forgenes of agronomic importance, e.g. insect resistance, grain quality and grain yield;
7. Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.
8. Protein arrays: basic principles; analysis of proteomics data, Identification of disease genes. SNPs, Metabolic pathways: KEGG, EMP.

Unit II The Gene transfer Techniques for the production of Transgenic

1. Overview of different gene transfer methods, plant vectors for transformation, transgene analysis and expression.
2. Indirect Gene transfer Methods: structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in Agrobacterium mediated gene transfer.
3. Direct gene transfer methods: Particle bombardment mediated transformation, Mechanism, Particle gun design, parameter for effective transformation; silicon carbide fiber mediated transformation and alternative methods.
4. Reporter genes, Selectable and scorable markers, Binary and Co-integrative vectors, Removal of marker genes, Applications and limitations of Agrobacterium gene transfer
5. Plastid engineering: Introduction, importance, scope and technique.

Unit III Crop Improvement and Agro-industrial biotechnology

1. Genetic Engineering for Herbicide resistance

2. Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance
3. Genetic engineering for Improvement of crop yield and quality: Protein, lipids, carbohydrates, vitamins & mineral nutrients;
4. Agro-industry:
Microbes in agriculture , Production and utilization of essential amino-acids, chemicals from micro-algae. Agro-waste utilization; Mycorrhiza in agriculture and forestry.

Texts/References:

1. SS Bhojwani & MK Razdan. *Plant Tissue Culture: Theory and Practice, a Revised Edition.* 2005. Elsevier.
2. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press,2008.
3. HS Chawla. Introduction to plant Biotechnology, 2nd Edition, Oxford & IBH,2002.
4. Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones**.** Biochemistry & Molecular Biology of Plants, ASPB Publication, 2008.
5. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
6. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
7. R J Henry, Plant Genotyping: The DNA Fingerprinting of Plants, CABI Publication, 2001.

MBT – 103: Plant Genetic Engineering (Credit 4) Unit I Unit Unit I Plant Tissue Culture: An

overview

Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

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marker genes, Applications and limitations of Agrobacterium gene transfer.

- Plastid engineering: Introduction, importance, scope and technique.

Unit IV Application of Genetic Engineering: Some Case studies

- Genetic Engineering for Herbicide resistance
- Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance
- Genetic Engineering for Vitamins and other value addition compounds
- Genetic Engineering for Production of pharmaceutically important compounds
- Genetic Engineering for Bioenergy generation
- Terminator technology

Unit V Molecular Mapping & Marker Assisted Selection (MAS)

Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

Texts/References:

1. SS Bhojwani & MK Razdan. *Plant Tissue Culture: Theory and Practice, a Revised Edition.* 2005. Elsevier.
2. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press,2008.
3. HS Chawla. Introduction to plant Biotechnology, 2nd Edition, Oxford & IBH,2002.
4. Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones**.** Biochemistry & Molecular Biology of Plants, ASPB Publication, 2008.
5. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
6. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
7. R J Henry, Plant Genotyping: The DNA Fingerprinting of Plants, CABI Publication, 2001

MBT-104: Mathematics and Biostatistics (Credit 4)

Unit I Calculus review

Calculus (Quick review of concepts): Review of limits, differentiability; Mean value theorem, Taylor's Theorem, Maxima and Minima; Fundamental theorem of Calculus; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives.

Unit II Ordinary Differential Equations

First order differential equations: Exact equations, Integrating factors and Bernoulli equations. Laplace transforms: Inverse theorem, shifting theorems, partial fractions.

Unit II Probability and Descriptive Statistics

Scientific notation: significant digits, rounding off, scientific notation, Error analysis; Counting and Probability: Addition rules; Permutations; Combinations; Inclusion-exclusion rule; Sampling with and without replacement; Conditional probability: Bayes' theorem; Independence; Descriptive statistics and Random variables; Measures of central tendency: mean, median, mode.

Unit IV Inferential statistics and one sample hypothesis testing

Samples and populations: Random, stratified and cluster sampling; Single- and Double-blind experiments; Point and interval estimates; Sampling distributions: *t*, chi-square, F distributions; Hypothesis testing: null and alternative hypotheses.

Texts/References:

1. Bernard Rosner, Fundamentals of Biostatistics, 5th Edition, Thomson Brooks/Cole, 2000.
2. Richard A. Johnson, Probability and Statistics for Engineers, 6th Edition, Prentice Hall, 2000.
3. Morris H. DeGroot, Mark J. Schervish, Probability and Statistics, 3rd Rev. Edition, Addison-Wesley, 2002.
4. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley, 2006.

MBT-104: Numerical Analysis and Biostatistics (Credit 4)

1. Sampling and presentation of data:

Application of statistics, variables, sampling method, Frequency distribution, Pie diagram, Bar diagram, Frequency polygon, Histogram, Frequency distribution curve, Scatterdiagram

2. Statistics of dispersion:

Variability, Range, Mean deviation, Standard Deviation, Variance, central moments, Coefficient of Quartile deviation, Coefficient of variation, Coefficient of dispersion.

3. Probability Distribution:

Probability mass function for discrete random variables and probability density function for continuous random variables; Skewness, Kurtosis, important discrete probability distributions: bernoulli, binomial, geometric, poisson, hypergeometric; important continous distributions: uniform, exponential, normal.

4. Regression:

linear, logistic, and multiple regression; correlation model—Application to biological science.

5. Testing Hypothesis:
Concepts and importance in experimental research, type of errors; testing means, Significance of difference between means using Z score; Large sample tests based on normal distribution – Test based on t and F distributions, Chi square test for goodness of fit, independence of attribute, homogeneity, and variance of a normal population.

6. Non-parametric and distribution-free statistics
introduction; some important nonparametric tests; Sign test, Wilcoxon's rank test and Spearman's rank correlation.

7. Analysis Of Variance:
One way and two way classifications of Anova – Applications from Biological Sciences – Case studies.

8. Solution Of Equations And Eigen Value Problems
Iterative method, Newton – Raphson method for single variable and for simultaneous equations with two variables. Solutions of a linear system by Gaussian, Gauss-Jordan, Jacobi and Gauss – Seidel methods.

9. Interpolation
Newton's divided difference formulae, Lagrange's and Hermite's polynomials. Newton forward and backward difference formulae.

10. Numerical Differentiation And Integration
Numerical differentiation with interpolation polynomials, Numerical integration by Trapezoidal and Simpson's (both 1/3rd and 3/8th) rules. Two and Three point Gaussian quadrature formula. Double integrals using Trapezoidal and Simpson's rule.

11. Initial Value Problems For Ordinary Differential Equations
Single step Methods – Taylor Series, Euler and Modified Euler, Runge – Kutta method of order four for first and second order differential equations.

Texts/References:

1. Debajyoti Das, Arati Das, Statistics in Biology and Pshychology, Academic Publisher
2. P.N. Arora, P.K. Malhan, Biosttistics, Himalaya Publishing House
Sastry, S.S., "Introductory Methods of Numerical Analysis (Third Edition)", Prentice Hall of India, New Delhi, 1998.
3. Kandasamy, P.,Thilakavthy, K. and Gunavathy, K. "Numerical Methods", S.Chand and Co., New Delhi ,1999.
4. Grewal B.S., Grewal J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, 1999.
5. Jain M.K., Iyengar S.R.K and Jain R.K., "Numerical Methods for Engineering and Scientific Computation (Third Edition)", New Age International (P) Ltd., New Delhi,

1995.
6. Gerald C.F., Wheatley P.O., Applied Numerical Analysis (Fifth Edition), Addison – Wesley, Singapore, 1998.
7. Narayanan S., Manickavachakam Pillai K. and Ramanaiah G., "Advanced Mathematics for Engineering Students-Vol.-III", S.Viswanathan Pvt. Ltd., Chennai, 1993.

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MBT-104: Numerical Analysis and Biostatistics (Credit 4)

Unit I Numerical analysis

Newton's divided difference formulae, Lagrange's and Hermite's polynomials. Newton forward and backward difference formulae. Numerical differentiation with interpolation polynomials, Numerical integration by Trapezoidal and Simpson's (both 1/3rd and 3/8th) rules. Two and Three point Gaussian quadrature formula. Double integrals using Trapezoidal and Simpson's rule. Single step Methods – Taylor Series, Euler and Modified Euler, Runge – Kutta method of order four for first and second order differential equations.

Unit II Sampling, presentation of data and dispersion

Application of statistics, variables, sampling method, Frequency distribution, Pie diagram, Bar diagram, Frequency polygon, Histogram, Frequency distribution curve, Scatter diagram, Variability, Range, Mean deviation, Standard Deviation, Variance, central moments, Coefficient of Quartile deviation, Coefficient of variation, Coefficient of dispersion.

Unit III Probability and Testing of Hypothesis

Probability mass function for discrete random variables and probability density function for continuous random variables; Skewness, Kurtosis, important discrete probability distributions: bernoulli, binomial, geometric, poisson, hypergeometric; important continous distributions: uniform, exponential, normal. **Testing Hypothesis:** Concepts and importance in experimental research, type of errors; testing means, Significance of difference between means using Z score; Large sample tests based on normal distribution – Test based on t and F distributions, Chi square test for goodness of fit, independence of attribute, homogeneity, and variance of a normal population.

Unit IV Multi-sample and nonparametric hypothesis testing

Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sum test; Kruskal-Wallis test; Analysis of variance: One-way ANOVA.

Unit V Curve fitting

Regression and correlation: simple linear regression; Least squares method; Analysis of enzyme kinetic data; Michaelis-Menten; Lineweaver-Burk and the direct linear plot; Logistic Regression; Polynomial curve fitting.

Texts/References:

1. Bernard Rosner, Fundamentals of Biostatistics, 5th Edition, Thomson Brooks/Cole, 2000.
2. Richard A. Johnson, Probability and Statistics for Engineers, 6th Edition, Prentice Hall, 2000.
3. Morris H. DeGroot, Mark J. Schervish, Probability and Statistics, 3rd Rev. Edition, Addison-Wesley, 2002.
4. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley, 2006.
5. P.N. Arora, P.K. Malhan, Biosttistics, Himalaya Publishing House Sastry, S.S., Introductory Methods of Numerical Analysis (Third Edition), Prentice Hall of India, New Delhi, 1998.
6. Kandasamy, P.,Thilakavthy, K. and Gunavathy, K.; Numerical Methods, S.Chand and Co., New Delhi ,1999.

7. Grewal B.S., Grewal J.S., Numerical Methods in Engineering and Science, Khanna Publishers, New Delhi, 1999.
8. Jain M.K., Iyengar S.R.K and Jain R.K., "Numerical Methods for Engineering and Scientific Computation (Third Edition)", New Age International (P) Ltd., New Delhi, 1995.

Electives

MBT-115A^{H}: Genomics & Proteomics (Credit 4)

Unit I Introduction

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencingprinciples and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, EST's and SNP's.

Unit III Proteomics

Protein analysis (includes measurement of concentration, aminoacid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI- TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV Pharmacogenetics

High throughput screening in genome for drug discoveryidentification of gene targets, Pharmacogenetics and drug development

Unit V Functional genomics and proteomics

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics

Texts/References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

MBT-115B : Advance Biochemistry (Credit 4) Unit I Cell Structure (Special

emphasis on Cell Wall & Membrane)

Organization of life, Importance of water, Cell structure and organelles, Biological Membranes, Membrane transport, Membrane Channels and Pumps, Active & Passive transport.

Unit II Proteins & Enzymes

Structure of proteins (primary, secondary, tertiary and quaternary structure, reverse turn), Ramachandran plot, peptide synthesis, protein sequencing, Enzymes: Basic Concepts and Kinetics. The Michaelis-Menten Model for Enzymes, Regulatory Strategies of Enzymes and Hemoglobin, Isozymes, Covalent modification as a mode of regulating enzyme activity, Enzyme activation by specific Proteolysis.

Unit III Metabolism and Bioenergetics: Carbohydrate metabolism

Review of bioenergetics, The concept of Gibbs free Energy, Exergonic and endergonic reactions, redox potential, High energy bond and key position of ATP, Carbohydrate metabolism: Glycolysis, Pyruvate Dehydrogenase complex, The Citric acid cycle, Pentose Phosphate pathway, Gluconeogenesis, Cori cycle, Glycogen metabolism, Glyoxalate cycle, Regulations of carbohydrate metabolism, Oxidative phosphorylation, Respiration and Electron Transport, Photosynthesis, Anoxygenic and oxygenic photosynthesis; Calvin cycle.

Unit IV Protein, Lipid & Nucleic acid Metabolism

Oxidation of fatty acids- mitochondrial and peroxisomal oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies, Biosynthesis of fatty acids, Phospholipids and glycosphingolipids-synthesis, Amino acid metabolism, Protein targeting, Basic nucleic acid structure, Biosynthesis of purines and pyrimidines.

Unit V Signal Transduction

Signal trunsduction: heterotrimeric G-proteins, Phosphatidyl inositol pathway, Tyrosine kinases: Map Kinase pathway, Ras Kinase pathway.

Texts/References:

1. L. Stryer, Biochemistry, 4th Edition, Freeman, 2002.
2. Voet & Voet, Biochemistry, 3rd Edition, 2004
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

MBT-115C : Bio-entrepreneurship and Management (Credit 4) Unit I Accounting and Finance

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for

working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

Unit II Marketing

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/Advertising; Services Marketing.

Unit III Negotiations/Strategy

With financiers, bankers etc.; with government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking.

Unit IV Information Technology

How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup; E-business management. Fundamentals of Entrepreneurship; Support mechanism for entrepreneurship in India

Unit V Human Resource Development (HRD)

Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up. **Role of knowledge centre and R&D:** Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

Case Study:

1. Candidates should be made to start a 'mock paper company', systematically following all the procedures.

• The market analysis developed by them will be used to choose the product or services.

• A product or service is created in paper and positioned in the market. As a product or services available only in paper to be sold in the market through the existing links. At this juncture, the pricing of the product or the service needs to be finalized, linking the distribution system until the product or services reaches the end consumer.

• Candidates who have developed such product or service could present the same as a project work to the Panel of Experts, including representatives from industry sector. If the presented product or service is found to have real potential, the candidates would be exposed to the next level of actual implementation of the project.

2. Go to any venture capital website (like sequoiacap.com) and prepare a proposal for funding from venture capital.

Texts/References:

1. Kawasaki, Guy. The Art of the Start: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything. New York: Portfolio, 2004.
2. Leong, Alan. Introduction to Writing a Business Plan. Bothell, WA: Center for Student Entrepreneurship, 2007.

3. Tracy, John, and Tage Tracy. How to Manage Profit and Cash Flow. Hoboken, NJ: John Wiley & Sons, 2004.
4. Kim, W. Chan, and Renée Mauborgne. Blue Ocean Strategy. Boston: Harvard Business School Press, 2005.

MBT-115D : Advances in Bioreactor design, Development and Scale up (Credit 4)

Unit I Inoculums development

Introduction to fermentation process, Microbial growth kinetics and media for Industrial fermentation, design of industrial nutrient media. Sterilization: Thermal death kinetics of micro – organisms – Batch and continuous Heat sterilization of liquid media – filter sterilization of liquid Media and Air. Inocula Development: Introduction – criteria for the transfer of inoculums – Development of inocula for: Yeast processes, Bacterial processes and mycelial processes – The Aseptic inoculation of plant fermenters.

Unit II Bioreactors

a. Batch and continuous culture: Chemostat: General principle, Balance equations critical dilution rate, Biomass productivity, comparison with batch cultures, residence time distribution, Test of validity, imperfect mixing, wall growth Transient state analysis,

Turbidostat, Chemostat in series Applications. Fed batch operation, Perfusion system, Bioreactor consideration in immobilized cell system.

b. Advanced Bioreactor: Stirred vessel reactors, Bubble column reactors, biochemical loop reactors and its applications, Biological wastewater treatment in reciprocating jet bioreactors, tower-shaped reactors for aerobic biological wastewater treatment. Membrane bioreactors.

c. Modeling and Scale Up of Bioreactor: Introduction, Modeling of bioreactors, the model cycles, kind of models, complexity of the model, solving equations, parameter sensitivity, experimental design / parameter optimization / testing of the model. Scale up of bioreactors: Introduction, scale up methods in use, fundamental methods, semifundamental methods, dimensional analysis, Rules of thumb, trial and error, Mechanistic background of dimentional analysis, the use of dimensionless groups for scaling up, heterogeneous systems, generation of dimensionless groups and some examples, regime analysis, method of regime analysis. Power input requirement, scale translation, types of fermenter, scale up of CSTR, design correlations, bulk mixing, scale up methods.

Unit III Bioreactor Instrumentation and Control

a. Measurement of physical and chemical parameters in bioreactors: monitoring and control of dissolved oxygen, pH, impeller speed and temperature in stirred tank fermenter.

b. Transport Phenomenon in Bioreactor: Oxygen demand, solubility, measurement of D.O.T. Redox potential, oxygen transfer, measurement of KLa (different methods). Agitation and mixing, Baffled, vortex and airlift

systems, Effect of stirring, sparging and other parameters, Power requirements for gassed and ungassed system, Rheology, O2 Transfer.

Unit IV Biochemical aspects of production

a. Product Formation in Microbial Cultures: Growth associated and nongrowth associated Kinetics, Energy Requirements: Electron transfer concept; Maintenance energy, magnitude and control of maintenance energy, Effect of maintenance.

b. Effect of Inhibition and Activation of Growth: Competitive and noncompetitive inhibition, Product and substrate inhibition, activators, Effect on batch and continuous systems.

Unit V Plant and Animal Cell Bioreactor

Plant cell bioreactors: characteristics of plant cell suspensions, plant cell bioreactor requirements, plant cell bioreactor design, plant cell bioreactor operation, alternative cultures for plant cells. Animal cells: Animal cell bioreactors, animal cell bioreactor operation, and animal cell bioreactor design.

Texts/References:

1. James E. Bailey and David F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill International Edition, New York, 1986.
2. "Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)
3. Schuler & Kargi, Bio-process Eng. PHI
4. Aiba S. and Nancy F. Millis, "Biochemical Engineering", 2nd Edn., Academic Press, New York,1973.
5. Web F.C, "Biochemical Engineering", Van Nostrand, London, 1964
6. Pauling M. Doran, Bioprocess engineering principles
7. Biotechnology Series edited by H. Bauer,
8. Biochemical Engineering, S.Aiba
9. Animal Cell Culture edited by Johr R.W. Master.

MBT-115E: Biophysical Chemistry (Credit 4)

Unit I Macromolecular structure and dynamics

Configurations and conformations of macromolecules; interaction of biological macromolecules with water and non-aqueous environments; factors that stabilize protein and nucleic acid structure; strong and weak interactions in biomolecules-electrostatic interactions, dipole-dipole interactions, VDW interactions, H-bonding.

Unit II Statistical thermodynamics of biological macromolecules

Partition function, methods for structural transitions in polypeptides and protein-coil helix transitions, structural transitions in polypeptides and protein helix-coil-helix transitions, melting and annealing of polynucleotide duplexes, helical transitions of double stranded DNA, prediction of helical structures in genomic DNA.

Unit III Optical Spectroscopic Methods for the Analysis of Structure and Function of

Macromolecules :

A. UV- Visible spectroscopy

Beer-Lambert's law; UV-VIS spectrophotometry in structure determination.

B. IR-Raman spectroscopy

Principles (e.g. frequency, wavenumber, vibrational modes, factors influencing vibrational frequency) and applications of IR, FT-IR and Raman spectroscopy to biomolecules.

C. Circular dichroism and optical rotatory dispersion

Linear dichroism of biological polymers; Use of circular dichroism in protein analysis; electronic CD of both proteins and nucleic acids.

D. Fluorescence Spectroscopy

Quantum Yield and Stokes shift, Fluorophores, steady state and time resolved protein fluorescence, Fluorescence lifetime measurements, solvent effects on emission spectra, fluorescence quenching, fluorescence anisotropy, Energy transfer, fluorescence sensing, fluorescence based DNA technology, Flow cytometry.

Unit IV 3D-Structure Determination Methods and Their Applications

A. X-ray diffraction

Space groups; crystal symmetry; Miller Indices, Bravais lattices, X-ray diffraction and Bragg's law, X-ray structure determination of biomolecules and accuracy/refinement of x-ray crystallographic structures.

B. Lasers in Biology and Medicine

Basic concepts of coherence and laser definition; types of lasers (Xe; Nd-YAG etc.); fiber optics technology; applications of lasers for biomolecular structure determination (e.g. LIF) and to medicine (surgery, ophthalmology).

Unit V Microscopy Based on Single Molecule Methods

Use of single molecule methods: Introduction, Electron Optics, The Transmission Electron Microscope (TEM), The Scanning Electron Microscope (SEM), Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM).

Texts/References:

1. C.R. Cantor and P.R. Schimmel; Biophysical Chemistry; Freeman
2. Keith Van Holde, Chien and Ho. Principles of Physical Biochemistry 2nd Edition Pearson
3. D.M. Freifelder; Physical Biochemistry: Applications to Biochemistry and Molecular Biology (Freeman)
4. J.R. Lakowicz; Principles of Fluorescence Spectroscopy (Springer)
5. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill)
6. Biological Spectroscopy- I.D. Cambell & R.A. Durk, (Benjamin Cummings)
7. Proteins: Structure and Function: David Whitford: John Wiley &Sons
8. Lubert Stryer : Biochemistry, 5th edn. (Freeman)
9. Voet and Voet: Biochemistry, 2nd edn. (Jhon Willey & Sons)

Laboratory

MBT-191: Recombinant DNA Technology lab (2 credits)

Experiments:

1. Isolation & restriction enzyme analysis of plasmid DNA by agarose gel electrophoresis
2. Isolation of genomic DNA from bacteria/animal tissue (any one) and restriction enzyme digestion (to show partial and complete digestion).
3. Isolation of total RNA /poly A mRNA.
4. cDNA amplification by RT-PCR, Ligation, Bacterial transformation, Selection of recombinant colonies.
5. Southern blotting, Northern blotting, Western blotting and ELISA.
6. Site directed mutagenesis using PCR.

MBT-192: Enzyme Technology Lab (2 Credits)

Experiments:

1. Production of alkaline protease in bioreactor, isolation of the enzyme and optimization of its activity.
2. Determination of kinetic coefficients for amylase, with and without inhibition (competitive, uncompetitive, noncompetitive).
3. Determination of specific growth rate, yield coefficient of microbial growth in bioreactor.
4. Development and operation of immobilized enzyme bioreactor.
5. Determination of KLa (volumetric mass transfer coefficient) using gassing out method.

MBT-192: Advanced Plant Biotechnology Lab (2 Credits)

Experiments:

1. Preparation of plant tissue culture media.
2. Techniques of *in vitro* culture (Explant selection sterilization and inoculation, Multiplication, subculture and hardening).
3. *Agrobacterium*-mediated transformation and transient GUS expression studies in tobacco.
4. Isolation of plant DNA.
5. Perform RAPD or ISSR to assess the genetic variability.

Semester: II

MBT-201: Advanced Bioinformatics (Credit 4)

Unit I: Sequence-alignment methodologies.

Sequence databases; Similarity matrices; Pairwise alignment: Features of dynamic Programming, alignment by Bayesian Statistical Methods, multiple sequence alignment: local multiple

sequence alignment: MEME, PSSM, HMM(algorithms and applications) Progressive methods for global multiple sequence alignment: CLUSTALW, PILEUP, T COFFEE; Statistical significance of alignment results.

Unit II: Pattern analysis in sequences
Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Units III: Pattern analysis in sequences and Phylogenetic tree construction methods Motif representation, Markov models; .Distance Based methods: clustering based methods,optimality based methods: Fitsch -Margoliash and Minimum evolution methods, Neighbor joining and related neighbor methods Character Based methods: Maximum parsimony methods, Maximum likely hood method, , genetic algorithm, Phylogenetic tree evaluation: Boot strap analysis; dendrogram and applications.

Unit IV: Structure-Prediction of Biomolecules with applications in Bioinformatics Structure classification of proteins (SCOP, CATH); Secondary structure prediction of various protein categories (e.g transmembrane proteins and helical proteins), RNA secondary structure prediction methods. Patterns, motifs and Profiles in sequences: Derivation and search methods;Derived Databases of patterns, motifs and profiles e.g Prosite, Blocks, Prints- S, Pfam. Overview of tertiary structure prediction methods; algorithms for modeling protein folding; algorithms for 3D structure prediction with representative examples. Protein structure prediction by comparative modelling approaches (homology modeling and foldrecognition); ab initio structure prediction methods.

Unit V: Molecular Modeling and drug design
Force fields and their evaluation (e.g MM2, AMBER) Monte Carlo and molecular dynamics simulations (e.g. GROMACS); simulation approaches towards protein and nucleic acid conformation determination; Energy minimization techniques; Structure comparison using database formalisms(DALI, VAST etc.); CASP for dry-wet structure comparisons. Classification of drug targets, Target discovery and validation methodologies Types of drug targets and characterization of drugs, Structure based drug design methods including computer-aided drug design (pharmacophore development) and recent technology developments; Target selection, Ligand(lead compound) design ,optimization and analysis; Protein-ligand docking; QSAR; physico-chemical molecular descriptors; ADME parameters and their optimization; drug deliverability, metabolism, toxicity and pharmacokinetics; molecular diversity and Combichem;, discussion of drug design to drug discovery to drug development with pharmaceutical/biotech drug case studies.

Texts/References:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis ,2nd Edition, CSHL Press, 2004.
2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
5. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd, Edition, Garland

Publishing, 1999.
6. W.B. Pratt and P. Taylor, Principles of Drug Action, Churchill Livingston
7. by W.O. Foye, T.J. Lemke and D.A. Williams, Principles of Medicinal Chemistry, Williams and Williams
8. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education
9. Scolnick.J.; Drug Discovery and Design, Academic Press, London,2001
10. N. R. Cohen, Editor, Guidebook on Molecular Modeling in Drug Design. Academic Press,
San Diego, 1996

MBT-202: Immunology (Credit 4) Unit I Fundamental

concepts and anatomy of the immune system

An overview of Immunology. First, second and third line of defense. Components of cell mediated and humoral immunity. Components of innate and acquired immunity;
Phagocytosis; Complement and Inflammatory responses; Haematopoesis; maturation of different immune cells. Organ and cells of the immune system- primary and secondary lymphoid organ.Gut, Mucosal and Cutaneous associated Lymphoid tissue (GALT,MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; adjuvant, Hapten-carrier system.

Unit II Major Histocompatibility Complex (MHC)

MHC genes, MHC and immune responsiveness and disease susceptibility, Structure of different MHC molecules**.** HLA typing laws of graft rejection; graft versus host reaction; Development of Inbred mouse strain; Blood group classification and Rh factor, Antigen processing and resentationendogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Cytokines and other co-stimulatory molecules.

Unit III Molecular basis of Immune response

Primary and secondary immune response**.** Kinetics of immune response. Immunoglobulins, class, sub-class and structure, Immunoglobulin superfamily, affinity, avidity. Allotype, Idiotype, Isotype, Antibody genes and antibody diversity, monoclonal and polyclonal antibody, Precipitation, agglutination, opsonization and complement mediated immune reactions; Different immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Microarrays, Transgenic mice, Gene knock outs.

Unit IV Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V Immune system in health and disease

Immunity to extracellular and intracellular microbes – bacteria, virus, fungi, parasites; Primary immune defficiencies (Lymphoid and myeloid lineages), AIDS and secondary immune defficiencies, Immune tolerance and Autoimmunity- pathogenesis of different diseases (Graves disases, Rheumatoid arthritis, Myasthenia Gravis, Multiple sclerosis, animal models of autoimmunity) and their treatment, Hypersensitivity. Transplantation immunology – graft rejection, immunosuppressive therapy, immune -tolerance, clinical transplantation. Cancer and immune system - tumor antigens, tumor evasion of the immune system, immunotherapy of cancer. Psychoneuroimmunology.

Texts/References:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.

MBT-203A: Bioprocess engineering & Technology (Credit 4)

Unit I Principles of enzyme catalysis and microbial growth

Proteins as enzymes; Michaelis-Menten kinetics; Kinetics and Statistics; Inhibition; Effect of pH and temperature; Enzymology; Immobilized enzymes: methods, mass transfer considerations; Industrial enzymes: Factors affecting microbial growth; Stoichiometry: mass balances; energy balances; Growth kinetics; Measurement of growth (an example from each group, particularly with reference to industrially useful microorganisms).

Unit II Bioreactors and Fermentation Design

Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; immobilized cells; Bioreactor operation; Sterilization; Aeration; Instrumentation & control, Culture-specific design aspects: plant/mammalian cell culture reactors. Description of industrial processes. Solid substrate, surface and submerged fermentation; Fermentation media; Fermenter design mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization;Upstream processing: Media formulation; Sterilization; Aerationand agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit III Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microbes; Strain improvement for increased yield and other desirable characteristics. Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins (Cellular control regulating production of

microbial metabolites – Primary and Secondary metabolite – Induced mutation technique – Analogue resistant mutant – Catabolic derepressed mutants – Genetically engineered strain – Protoplast fusion technique). Industrial microbes as cloning hosts (Streptomyces/Yeast). Recombinant protein production in microbes; Commercial issues pertaining to the production recombinant products from microbes.

Unit IV Applications of enzymes in food processing

Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Inter-esterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucosesoxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing. Applications of Microbes in food process operations and production: Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful, Production of Bioethanol, Biohydrogen and biopesticides.

Unit V Industrial Processes and Process economics

Process flow sheeting; Process economics; Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation. Case Studies.

Text/References :

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
3. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
4. Pauline Doran, Bioprocess engineering principles, 1 Edition, Academic Press, 1995.
5. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
6. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.
7. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
8. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
9. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India, Private Ltd, India, 2004.

MBT 203B Bioprocess Technology (Credit 4)

Principles of Enzyme catalysis and large scale purification of enzymes(10 L)

Fundamentals of Enzyme Kinetics: Enzyme nomenclature, Units of Enzyme, Mechanism of Enzyme reaction, Reversible reactions, Enzyme kinetics, Enzyme inhibition, determinations of kinetic constants (2L)Large Scale

Production of Enzyme: Sources of Enzyme, Preparation of Enzyme, Centrifugation,Filtration, Aqueous Two-Phase system, Cell breakage - Ultrasonic, High pressure homogeniser, Bead mills, Freeze-press, Lytic enzyme, Ultrafiltration and Reverse osmosis, Concentration of enzyme, Stabilization of enzyme, Commercial preparations (5L)
Purification of Enzymes: Heat treatment, Chromatography – Adoption, Ion exchange, Hydrophobic, Affinity, Gel-exclusion, (3 L)

Application of Enzyme in Large Scale Industries (10 L)
Food Processing- Dairy, Bakery, Fats & oil, Brewing , Cheese Production ,Corn and High Fructose Syrup (5L)
Enzyme Processing of Industrial Products – Detergent , Leather & Wool , Textile & Cotton, , Paper & Pulp (5L)

Bioprocessing of Food (10L)
Bioprocessing of food for nutraceuticals –Lipid based nutraceuticals , polar lipid, PUFA, protein.Polysaccharide,nucleotide, other small molecular weight compounds (5L)
Functional Food production - Dietary fibre, Food Gum,Emulsifier & Surfactant, Artificial Butter,Favoring agent , Alternative Sweetener , Antioxidant , Preservatives (5L)\

Microbial Bioprocess (!0L)
Bioremediation of Heavy metal and Polynucleated hydrocarbons (3L)
Biohydrogen and Bioethanol (3L)
Bioleaching of metal Ores (2L)
Biopesticide Production (2L)
Reference;
1. “Enzyme Technology” by A. Pandey, C. R. Socol, C. Webb, (2006), Springer.
2. “Enzyme Technology” by W.L. Goldstein, (1979), Academic Press
3. “Enzymes in Industry:Procedure and Application“ (1990) By W. Aehie, Wiley-WeH Pub.:
4, “Fundamentals of food biotechnology” (1996) by H. Lee, Wiley IEEE
5. “Functional Foods & biotechnology” (2006) by K. Shelly, CRC Press.
6.“Biotechnology and Food Ingredients” (1991) G. Richard, Springer.
7.“Fundamental Food and Nutraceuticals” (2006) by J. Shi, CRC Press

MBT-204: Downstream Processing (Credit 4)

Unit I Requirement of Downstream Processing
Basic concepts of separation Technology, Overview of a bioprocess including upstream and downstream processing, Importance of downstream processing in biotechnology, characteristics of biological molecules, New Separation process in modern biotechnology; Separation characteristics of proteins and enzymes – size, stability & other biological properties; Selection of purification methodologies, Characteristics of fermentation broth & its pretreatment.

Unit II Biomass Removal and Disruption

Biomass removal and disruption: Cell disruption by Mechanical and non mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, Types of Homogenizers, Centrifugation; Sedimentation; Flocculation.

Unit II Product Isolation

Liquid - liquid extractions, Precipitation (salt, pH, organic solvent, high molecular weight polymer). Separation of particulate by filtration, Rotary Vacuum Filtration, Centrifugation & Ultracentrifugation (Batch, continuous, basket), settling, sedimentation, decanting; Electrophoresis.

Unit III Membrane Based Separation

Membrane based purification: Microfiltration, Ultrafiltration, Reverse osmosis (UF and RO); Dialysis; Electrodialysis; Diafiltration; Pervaporation; Perstraction, Biotechnological application, Structure and characteristics of membranes; Liquid membranes; Supported liquid membrane; Membrane reactors.

Unit IV Separation by Adsorption and Chromatography

Types of adsorption; adsorbents types, their preparation and properties, Types of adsorption isotherms and their importance; Chromatography: general theory, partition coefficients, zone spreading, resolution and plate height concept and other chromatographic terms and parameters; chromatographic method selection; selection of matrix; separation based on size, charge, hydrophobicity and affinity**:** Gel filtration, Ion exchange chromatography, Affinity chromatography, IMAC chromatography; Covalent chromatography; Reverse phase chromatography (RPC) and hydrophobic interaction chromatography (HIC), HPLC, role of HPLC in protein characterization; Chromatofocussing; Polishing of Bioproducts by Crystallization of small and large molecules, drying and Formulations.

Unit V Case Studies

Baker's yeast, Ethanol, Power alcohol, Citric acid, Intracellular proteins, Penicillin, Streptomycin, Insulin, Casein, interferon, Large scale separation and purification of *E.coli*, yeast, Recombinant products.

Texts/References:

1. E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press, 1989.
2. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley- Interscience Publication, 1988.
3. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Seperation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong
5. Priniciples of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
6. Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)
7. Biotreatment, Downstream Processing and Modeling" (Advances in Biochemical

Engineering /Biotechnology, Vol 56) by T. Schepler et al, Springer Verlag
8. Chromatographic and Membrane Processes in Biotechnology" by C.A. Costa and J.S. Cabral, Kluwer, Academic Publisher
9. Downstream Processing" by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society
10. Protein Purification" by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society ,Verlag
11. Protein purification: Principle and practice, third edition, Robert k. Scopes, Springer, editor: Charles R. Cantor
12. Physical Biochemistry: David Friefelder, 5th Ed, PHI
13. Guide to protein purification: Methods in enzymology, volume 182

MBT 291: Bioinformatics Laboratory (2 Credits)

Experiments:

1. Introduction to Bioinformatics lab and some useful terminologies. Handling of different primary databases and retrieval of primary data of both protein and nucleotide (Expasy, Entrez) of a particular group or type of an enzyme. Handling of different specialized databases: Pathway-KEGG, Disease databases (cancer and other disease databases), protein folding classification databases-FSSP, different genomic databases.
2. Different approaches of Prediction of Genes: Promoters, splice sites, regulatory regions (Basic principles) application of methods to prokaryotic and eukaryotic genomes and interpretation of results.
3. Sequence based and structure-based approaches to assignment of gene functions, e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc.
4. Different approaches of Identification of Disease Genes: Based on some specialized general databases and specific disease databases.
5. Use of various derived databases in structure and function assignment, gene expression profiling.
6. Different approaches for analysis of ligand-protein and protein- protein interactions.
7. Study to find out potential drug targets for cardio vascular, neurological diseases etc. using proprietary and public domain softwares (eg. VEGAZZ) (ligand design, optimization and improvement).

MBT-292: Downstream Processing Laboratory (2 Credits)

Experiments:

1. To produce potable water from seawater using Reverse Osmosis system.
2. Enzyme purification using ultrafiltration membranes.
3.a) Determination of alcohol percent composition in alcohol water mixture using Gas Chromatography.
b) To determine CO2 / CH4 percent composition in standard air sample using Gas Chromatography.
4. Gel Filtration study of enzyme mixtures.
5. Citric Acid production and purification by chemical method.
6. Downstream Processing of immunoglobulin.

MBT-292: Immunology Lab (2 Credits)

1 Preparation of Plasma and Serum.

2. To study of ABO & Rh Grouping by Rapid Slide Method & tube method

3. Blood smear identification of leucocytes by Giemsa stain

4. To study of precipitin reaction by Immunodiffusion.

5. Simple Immunodiffusion & Double Immunodiffusion (Ouchterlony technique)

6. Antibody titre by ELISA method.

7. SDS-PAGE, Immunoblotting, Dot blot assays

8. To study agglutination reaction for Enteric fever (WIDAL).

MBT-292: Animal Cell Culture Lab (2 credits)

PARTA:

1. Basic sterilization techniques for animal cell culture.
2. Preparation of complete medium

3. Trypsinization, freezing, thawing of cells.

4. Serum starvation study.

5. Toxicity study by MTT assay

6. Transfection

7. Proliferation assay

Optional

7. Tumorigenic potential of a gene

8. MN assay

PARTB:

1. Synthesis of nano structured semiconducting thin films and nanoparticles by sol-gel method.

2. Study of Optical absorption and estimation of optical bandgap of semiconducting thin films and nano-structure.

Optional, provided the instruments and consumables are available

3. Structural study of nanomaterials by X-ray diffraction.

4. Imaging analysis of nanomaterials by Electron-microscopy, surface topography by AFM

5. Fabrication of core-shell structure and study of bioconjugation.

6. Development of Nano-luminescent tags –for bio-imaging, in vivo imaging (tumor shell detection, early cancer detection etc).

Electives

MBT-215A: Animal cell culture & its application (Credit 4)

Unit I
Cell culture Laboratory design & Equipments, History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.;
Behavior of cells in culture conditions: division, growth pattern, estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

Unit II
Media and reagents, Different types of cell cultures, scale up

Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

Unit III
Application of animal cell culture

Toxicological study, cell cycle regulation study, apoptosis, drug testing

Unit IV
Nanotechnology: Definition of nano scale with reference to biosystems, Scope (Overview of current industry applications) and future prospects (Engineering principles for nanotechnology materials and applications). Physics of nano-structure - Quantum Size effect - optical properties, Semiconductor (magnetic, organic, and

doped nanoparticles) - Synthesis of bio-metric materials (Quantum dot, thin film etc) – Characterization techniques - Role of surfaces in nanotechnology devices – Nano fabrication nanotubes, nano-probes - biosensor. 10L

Unit V

Nanotechnology in Biomedical and Life Sciences: Criteria for suitability of nanostructures for biological applications, Lipids as nano-bricks, Proteins as nanomolecules, DNA in nanotechnology, Present and future of nanotechnology applications in: a) Molecular biology (e.g. Hairpin Nanoprobes for gene detection, Control of Biomolecular Activity by Nanoparticle Antennas, Nanofibers and their applications in tissue engineering), b) Medicine (Public acceptance of nanomedicine, nanostructures for drug delivery, concepts, targeting, routes of delivery and advantages). 10L

References:

1. Nanochemistry: A Chemical Approach to Nanomaterials (Hardcover) by Geoff Ozin, A Arsenaultn (Publisher: Royal Society of Chemistry; 1 edition (November 22, 2005) ISBN: 085404664X)
2. Nanoscale Technology in biological systems, Ralph S. Greco, Fritz B. Prinz, R. Lane Smithm CRC Press, 2005
3. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience by Edward L. Wolf (Publisher: Wiley-VCH; 2 edition (October 20, 2006) ISBN: 3527406514)

4. Cancer Nanotechnology, eds. H. S. Nalwa and Thomas Webster, American Scientific Publishers, 2007, ISBN: 1- 58883-071-3

7. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens; John Wiley & Sons, 2003, ISBN 0471079359

8. L.E.Foster, Nanotechnology-Science, Innovation and opportunity, Person eduction inc, 2007.

9. Freshney R. Ian, “Culture of animal cells: A manual of Basic Technique”, Willey-Liss Publisher, 5th edition (2005).

10. Morgan, Animal Cell Culture-Biotol Series,1993

11. Davis.J.M Basic Cell Culture Second Edition, Oxford University Press. (First Indian Edition, 2005)

12. Jenkins N, ed., “Animal Cell Biotechnology: Methods and Protocol”, Humana Press (1999).

13. Minuth W.W., Strehl R., Schumacher K., “Tissue Engineering: Essential for Daily Laboratory Works”, Willey Publisher (2005).

14. Butler, M “Mammalian Cell Biotechnology- A Practical Approach,” IRL Oxford University Press (1991)

MBT-215C : Nano Biotechnology (Credit 4)

Unit I Nanotechnology
Definition and concepts; Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications.

Unit II Basic characterization techniques
Electron microscopy; Atomic force microscopy; Photon correlation Spectroscopy.

Unit III Thin films; Colloidal nanostructures
Nanovesicles; Nanospheres; Nanocapsules.

Unit IV Health Care Nanotechnology
Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging.

Texts/References:

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley- VCH Verlag GmbH & Co. KGaA ISBN: 3527304401.
2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley- Liss ISBN: 047141719X.
3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-8247-2579-4.
4. Springer Handbook of Nanotechnology- B Bhusan

MBT 215B: Genomics & Proteomics (Credit 4)

Unit I Over view of proteomics
Method used in proteome analysis; Protein purification techniques (ion exchange, affinity, FPLC, Gel filtration, hydrophobic interaction and 2-D Gel electrophoresis, SDS PAGE, isoelectric focusing); Characterization and identification of proteome using mass Spectrometry, MALDI- TOF, Tandom mass spectrometry; Protein sequencing by Edman degradation and analysis.

Unit II Protein Array

Type of protein arrays, data analysis, application of protein microarrays, protein and enzyme assays.

Unit III Protein folding

Thermodynamics and kinetics, energy landscapes in protein folding mechanism of Gro EL/ES function, posttranslational folding trigger factor. Chaperons and protein degradation; Drug discovery, diagnosis and treatment, and protein Engineering.

Unit IV Introduction to the human genome project

Physical mapping and sequencing of the genome; Sequence analysis, comparative homologies; Evolutionary changes and single nucleotide polymorphism; Expression: analysis of expressed genes; Post genomics.

Texts/References:

1. Genomics and Proteomics Functional and Computational Aspects- Sáinder Suhai, Kluwer Academic Publishers.
2. Genomes- T. A. Brown, John Wiley and Sons.
3. Proteins and Proteomics- Richard J. Simpson, I. K. International Pvt. Ltd.
4. Proteomics in Practice- A Laboratory Manual of proteome Analysis- Tom Naven.
5. Molecular Cell Biology- H. Lodish, A. Berk, P. Matsudaira, C. A. Kaiser, M. Krieger, Matthew P. Scott, L. Zipursky, James Darnell.

MBT-215C: Teaching Methodology in Technical Education (Credit 4)

Unit I Philosophy and Education

Concepts of Philosophy and Education. Relationship between Philosophy and Education. Schools of Philosophy - Idealism, Naturalism, Pragmatism, Realism and their impact on Education with reference to aims, curriculum, methodology, discipline and place of teacher. Aim - Individual and Social.

Unit II Learning

a. **Types of Learning:** Concept Learning - Steps involved in Teaching for Development of Concept. Skill Learning - Meaning, Stages of Development, Teaching strategy.
b. **Learning Process and Teaching:** Learning Theories - Conditioning (Classical and Operant), Connectionism, Gestalt or Cognitive.
c. **Factors Affecting Learning:** Biological - Maturation. Psychological - Motivation, Perception, Attention and Interest, Imagination, Memory and forgetting.
d. **Teaching and Learning:** The Concept of Teaching - various modalities of teaching such as, Training, Instruction, Conditioning, Indoctrination, and Educative Teaching. Different Levels of Learning and Teaching - memory, understanding and reflective.

Unit III Teaching Strategies

Concept of Teaching Strategies - difference between Teaching Strategies and Teaching Tactics. Classification of Teaching Strategies - Mastery Learning, Personalised System of Instruction, Programmed Instruction, Computer Assisted Instruction, Simulation and Gaming, Brainstorming and Auto-tutorial Instruction

- their characteristics, advantages and limitations.

a. Models and Theories of Teaching: Types of Teaching Models - Inquiry Training Model, Aptitude Treatment Interaction Model, Behavioural Model their nature, characteristics, merits and limitations. Theories of Teaching - Cognitive Development Theory, Theory of Instruction - their nature, characteristics, merits and limitations.

b. Teaching Effectiveness: Variables involved in Teaching Effectiveness. Techniques for enhancing Teaching Effectiveness - Verbal Interactional Analysis Techniques. Micro- teaching and Simulated Teaching. Assessment of Teaching Effectiveness.

Unit IV Intelligence and Creativity

Meaning and theories of Intelligence. Measurement of Intelligence, Types of Intelligence Tests, Uses and Limitations of Intelligence Tests. Creativity - Meaning, Dimensions (Fluency, Flexibility, Originality and Elaboration), Development of Creativity through Education. Gardner's Theory of Multiple Intelligences, Bloom's taxonomy

Unit V Technological Aids in Teaching-learning

Technological Aids - Teaching Machines, Computers and Laboratories and Audio-visual Appliances - their nature, characteristics, advantages and limitations. Case Studies and problem Solving

Texts/References:

1. Broundy, HS; Building a Philosophy of Education, Prentice Hall of India, New Delhi, 1965.
2. Burnard, H W and Hilgard,,Ernest R; Psychology of Science and Teaching, MeGraw-Hill Book Company Ltd., New York, 1965.
3. Brown, Gordon H; Theories of Learning, Prentice Hall of IndiaPvt.Ltd.,New Delhi,1986.
4. Chand, Tara; Educational Technology, Anaval Publications, New Delhi,1990.
5. Dwight, Allen & Rayan, Kevin; Micro-teaching, Addison Wesle Pub. Co., Monachustter, 1969.
6. Hoover, Kenneth; College Teaching Today: Handbook for Post Secondary Instruction, Allyn Bacon, Ine, London, 1980.
7. Selected Papers and Reviews

MBT-215D: Genomics and Proteomics (Credits 4)

Unit I Genomics

1. Genome Evolution and overview of genomic anatomis: [2 L]

Origin of Genomes, Eukaryotic nuclear genomes, Eukarytotic organelle genomes, anatomy of prokaryotic genomes. Overview of genome database.

2. Approaches for Gene Identification and Gene Prediction: [4 L]

Prediction of genes, promoters, Splice sites, regulatory regions, Basic principles application of methods to prokaryotic and eeukaryotic genomes and interpretation of results.

3. Structural Genomics: [3 L]

Basic principles, Technology, Data Bases (NCBI and Plant Databases), Sequences Comparison techniques (BLAST etc.).

4. Functional Genomics: [5 L]

ESTs, Digital Northern, SAGE, molecular markers in genome analysis, RFLP and AFLP anlysis, Microarray (Basic principles and technology of cDNA microarrys, oligonucletide microarray chips, Cancer and genomic microarrays) Examples for application of microarrays, Microarray data analysis. Transcriptomics, Use of various databases in function assignment.

5. Molecular Phylogenetics and comparative Genomics: [4 L]

Gene duplication and phylogeny, Gene order, Horizontal gene transfer, Transposable element clusters of orthologous genes, DNA based phylogenetic trees, Application of molecular phylogenetics.

6. Genomic Variation: [3 L]

SNPs, AFLP and RFLP analysis, Arabidopsis KO Strategies, Pharmacogenomics, Ethical consideration of genetic testing.

Unit II Proteomics

1. Introduction and Tools for Proteome Analysis: [9 L]

What is proteome? 2D gel electrophoresis, High-throughput proteome analysis with 2DIEF, Current concepts of co-immunoprecipitation for protein interaction analysis, chromatography, amino acid sequencing, Current concepts of peptide sequencing with MS-MS methods, MALDI-TOF mass spectrometry and ESI-TOF MS, phage display, protein chips, Yeast Two- Hybrid (Y2H) methods, Synthetic lethal screen, Proteome-wide interaction maps, TAP tags, GFP tags, inteins and protein splicing for interaction analysis, protein array (Microarray- affimatrics and spotted array concepts).

2. Protein Structure and function Relationship: [6 L]

Protein-protein interactions for large molecular complexes (RNA polymerase II, ribosome), Databases for analysis for protein-protein interaction, Unstructured proteins (Current concepts and examples, the fly-casting mechanism). Current degradation concepts, the N-end rule and PEST sequences, control of ubiquitination, proteosome, SUMO Protein-protein interaction in health and disease.

3. Nuclear Magnetic Resonance Spectroscopy (NMR): [3 L]

Basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR, NOESY, COSEY. 4.

X-ray **Crystallography: [3 L]**

Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.

References:

1) "Genomes II" by T. A. Brown.
2) "Human Molecular Genetics 3" by T. strachan and A. P. Read, Garland Science Pub.
3) "Principles of Genome analysis" by S.B. Primrose and R. M. Twyman,
4) "Genomics: Application in Human Biology" by S.B. Primrose and R. M. Twyman.
5) "Functional Genomics: A practicqal Approach" by S. P. Hunt and R. Livesey, Oxford University Press.
6) "DNA Microarry: A practical approach" by M. Schlena, Oxford University Press
7) "Discovering Genomics, proteomics and Bioinformatics" by A. M. Campbell and L. J. Heyer.
8) Essentials of Genomics and Bioinformatics by C. W. Sensen, mJohn wiley ans sons Inc.
9) "Proteomics" by T. Palzkil, Kluwer Academic pub.
10) "Protein and Proteomics" by Richard J Simson, I K publisher
11) "Principles of Proteomics" by M. Twyman ; Bioscientific Publishers
12) "Introduction to Proteomics: by D. C. Liebler, Tools for the New Biology", Humana

Press
13) Molecular Biology of the Cell, by B. Alberts, D. Bray, J. Lewis et al, Garland Pub. N.Y 1983
14) Genomics, by Cantor & Smith John Wiley & Sons

MBT – 215E : Genetics (Credits 4) Unit I Prokaryotic

genetics:
Basic genetics; genetic code and chromosome theory of inheritance, Conjugation, transduction and transformation, host cell restriction (restriction endonucleases), complementation, molecular recombination, mapping of bacterial genes, horizontal gene transfer

Unit II Fungal genetics:
Life cycle of yeast, recombination and linkage in yeast, tetrad analysis, genetic map vs physical map, yeast vectors, mutant hunts (forward and reverse genetics), selection and screening strategies, mating type switching, yeast two-hybrid system, C. elegans genetics, RNA interference

Unit III Mammalian genetics
Mendel's experiments, monohybrid and dihybrid cross, sexual reproduction, application of chi square test, deviation from Mendelian segregation, linkage, genetic map, Mendelism in human genetics: pedigree analysis, dosage compensation and sex determination, inheritance characteristics of sex linked and autosomal traits, chromosome discovery, chromosomes as physical basis of inheritance, Polytene and lampbrush chromosome, chromosomal abbertions and genetic load, sex linked deleterious genes, extrachromosomal/ non Mendelian inheritance (episomes, mitochondria and chloroplast), parental imprinting.

Unit IV Medical genetics
Autosomal dominant and autosomal recessive, trinucleotide repeat disease, genetic counseling.

Unit V Population genetics
Variation and its modulation, effect of sexual reproduction on variation (Hardy-Weinberg Equilibrium), sources of variation, selection balanced polymorphism, random events.

Reference:

1. G. Stent: Introduction to Molecular Genetics
2. M.W. Strickberger: Introduction to Genetics
3. Anthony J. F. Griffith: Introduction to Genetic Analysis
4. R.W. Old and S.B. Primrose: Principles of gene manipulation

MBT – 215H : Cell Biology (Credits 4) Unit I DNA and

chromosome
Cell Chemistry and Biosynthesis, chemical components of cells, catalysis and use of energy by cells, how cells obtain energy from food. The structure and function of DNA, chromosomal DNA and its packaging in the chromatin fibre, the global structure of chromosomes.

Unit II Visualizing Cells
Looking at cell structure with microscopes, visualizing molecules in living cells

Unit III Membrane Structure, Transport & Electrical Properties of membranes
Lipid bilayer, membrane proteins Principles of membrane transport, carrier proteins and active membrane transport

Unit IV Intracellular compartments and protein sorting
Compartmentalization of cells, transport of molecules between the nucleus and cytosol, transport of proteins into mitochondria and chloroplasts, peroxisomes, endoplasmic reticulum.

Unit V Intracellular Vesicular Traffic

Molecular mechanisms of membrane transport and maintenance of compartmental diversity, transport from ER through the Golgi apparatus, transport from the trans-golgi network to lysosomes, transport into the cell from the plasma membrane via endocytosis, transport from the trans-golgi network to the cell exterior via exocytosis.

Unit VI Energy conversion in mitochondria and chloroplasts
The mitochondria, electron transport chains and their proton pumps, Chloroplasts and photosynthesis, the genetic systems of mitochondria and plastids, the evolution of electron transport chains.

Unit VIII Cell Communication
General principles of cell communication, signaling through G-protein linked cell surface receptors, signaling through enzyme linked cell surface receptors, signaling pathways that depend on regulated proteolysis

Unit IX The Cytoskeleton
The self assembly and dynamic structure of cytoskeletal filaments, how cells regulate their cytoskeletal filaments, molecular motors, the cytoskeleton and cell behaviour.

Unit X The Cell Cycle and programmed cell death
An overview of the cell cycle, components of the cell cycle control system, intracellular control of cell cycle events, apoptosis, extracellular control of cell division and cell growth.

Unit XI Cell Junction, Cell Adhesion and Extracellular Matrix
Cell junction, cell-cell adhesion, the extracellular matrix of animals, integrins, plant cell wall.

Reference:
1. H.R. Lodish et al.: Molecular Cell Biology

2. Bruce Alberts et al and J. D. Watson: Molecular Biology of the Cell

MBT – 215F: Bio-entrepreneurship and Management
(Credits 4)

Unit I Entrepreneurship – Objectives and Fundamentals

Entrepreneur & Entrepreneurship concept; role of entrepreneurship in economic development; factors affecting entrepreneurial growth; developing and evaluating opportunities; securing resources – institutional finance to entrepreneurs, lease financing & hire purchase, institutional support to entrepreneurs; statutory & legal requirements for starting a venture/ company; how to write a business plan

Unit II Growing & sustaining enterprise

Developing start-up strategies, measuring market opportunities – Forecasting & market knowledge, market assessment, market segmentation, branding & packaging, pricing policy,
distribution channels; Introduction to financial accounting – balance sheet, profit & loss account, cash flow statement; book keeping – accounting procedure, records & systems; introduction to costing for decision making; income tax, sales tax, excise duty.

Unit III Growing & sustaining enterprise

How to use IT for business administration, use of IT in improving business performance, e- business set-up. Organizational structure; human resource planning – recruitment, selection, induction, promotion & exit; performance appraisal, training & development, remuneration & benefits

Unit IV Role of knowledge centres

Knowledge centres like Universities & research Institution, Role of technology & upgradation, managing technology transfer, regulations for transfer of foreign technologies, support mechanism for entrepreneurship in India.

MBT – 215G : Agriculture Biotechnology (Credits 4) Unit I General Principles of

Agriculture [3L+0+1 = 4]

Agriculture in India; World agriculture in relation to trade in commodity, biodiversity and agricultural process outsourcing; Global warming and challenges of agriculture – global warming, factor (soil, water and crop) productivity; Cropping systems; Varieties and cultivars; Agronomic practices and Good Agricultural Practices; Crop diseases and pests, their control; Abiotic stress, their amelioration; Pollution in and by agriculture. Origin and expansion of biotechnology; Non-rDNA and rDNA biotechnology; Application of biotechnology in agriculture; Scope of agricultural biotechnology.

Practical

Weekly field visits to assigned cropping systems; Preparation and maintenance of Field Report Book with photographic evidence.

Unit II Agricultural Genetics and Plant Breeding **[3L+0T+1P = 4]** Eukaryotic chromatin structure; Chromosome replication; Structure, organisation and manipulation of eukaryotic genes; rRNA gene; Histone gene; Molecular genetics of photosynthesis; Molecular genetics of nitrogen fixation; Molecular genetics of stress (abiotic and biotic). Principles and practice of plant breeding of major crops (rice, wheat and one vegetable crop); Morphological and molecular markers; Agricultural Biodiversity and its dynamics; Sources of variation; Seeds and production of seeds; Biofertilisers; Mycorrhizae; Biopesticides; Pharming; Use of agriculture of mass scale production of energy, secondary metabolites and fortified consumables.

Practical

Principles of microscopy and optics; Staining of pro- and eukaryotic cells (prokaryotic gram staining, eukaryotic chromosome staining); Root tip mitosis, pmc meiosis, and karyotyping;

Microtomy; Microphotography; Photography for record and analysis. Acquaintance with seed production, in vitro plant propagation; production of biofertilisers, Mycorrhizae and biopesticides. [Conducting one experiment and industrial visits]

Unit III Techniques in agricultural biotechnology **[2L+1T+2P = 5]**

Cell fractionation: Genomic, Mitochondrial and Chloroplast DNA, and Protein isolation and characterization; Plant tissue culture technique for one selected crop: Collection of material, Sterilization; Media preparation; Media manipulation; Culture maintenance; Culture characterization; Biochemical and cytological characterization; Hardening; Field transfer of plantlets.Transformation/transgenesis; Selection of desired transgenics in vitro and their establishment in the field condition; Laws relating to rDNA safety protocols.

Unit IV Transgenic crops **[3L+0T+0P = 3]** Traditionally bred and transgenic crops; Details of one selected transgenic crop; Trends in transgenesis of crops; Laws relating to transgenics; Controversies and remedies; Business and international trade in agricultural biotechnologies. International protocols and instruments relating to agricultural biotechnology; Indian laws relating to agriculture, biotechnology and biodiversity; IPR consideration in planning of agricultural biotechnology experiments; Confined and field trials.

Semester: III

MBT-315A: Research methodology and scientific writing

(Credit 4)

Unit I Introduction to Research methodology:

Development of hypothesis. Logical reasoning and analytical thinking. Planning and scientific strategy. Designing research methods. Setting up of scientific goals. Introduction to scientific statements Dimensions and properties Comparison and Models of research.

Unit II Critical reading of scientific paper

Outline of scientific paper – planning of parts. Title, Introduction and Summary/abstract Materials and methods – importance of measurements, reproducibility, statistics, confidence. Results: Text, data presentation, methodology: Tables, graphs, histograms, photographic plates, legends. Discussion: Logical presentation and critical analysis of ideas and data, conclusions Citations: How to find references from journals, books etc

Unit III Testing of Hypothesis and Experimental design

Specific search for similar hypothesis. Designing methods in order of simple to complex methodologies. Reverse testing of data by alternative methods. Double blind and randomization of protocol. Unbiased analysis. Data interpretation at multiple levels and integrating the broad idea. Reproducibility of data. Significance and correlation analysis.

Unit IV Language of Science and lucidity

Understanding the definitions of scientific principles and their description. Developing the skill of differentiating scientific terms from colloquial terminologies. . Impersonal Scientific Statements More Informative statements, Experimental and Explanatory Descriptions Concise Statements and summary skills.

Unit V Presentation skills-writing/oral

Seminar Skills and preparing PowerPoint slides. Logical presentation and critical analysis of ideas and data. Art of Scientific writing, Differentiating Short communications, Scientific reports Articles and reviews. Referencing and Indexing. Organizing Coherent paragraphs Using various software for writing scientific papers. End note and reference manager.

Texts/References:

1. Research Methodology (2 Vols-Set) Suresh C. Sinha and Anil K. Dhiman, Ess Ess, 2002, 860 p, 2 volumes, ISBN : 81-7000-324-5(Vol. I); 81-7000-334-2 (Vol. II)
2. Doing Your Research Project: by Judith Bell A Guide for First-Time Researchers in Education, Health and Social Science (4th Edition)
3. Writing Scientific English, John Swales, 51 York Palace Edingurgh.
4. From Paragraph to Essay, Imhoof
5. English Grammar and Composition, Houghton Miffin
6. Case Study Research: Design and Methods (Applied Social Research Methods) by Robert K Yin

MBT-315B: Nanotechnology (Credits 4)

Unit I Nanotechnology –Introduction, Concepts and origin

Introduction and definition of nanotechnology, importance and role of nanoscale science and technology in the current context-pros and cons; history and development of nanotechnology –contribution of scientists and technologists.

Unit II Latest developments and future of nanotechnology

Intoduction, Silicon based technology and molecular manufacturing; introduction to nanotechnology applications in diverse fields (e.g. nanobiotechnology, nanomaterials); nanotech device developments (e.g. nanotubes, biosensors, solar cells).

Unit III Properties of nanomaterials

Introduction, nanochemistry including self-assembly of materials; nanoparticles, carbon nanotubes, nanocomposites; synthesis and characterization of such materials

Unit IV Nanobiology

Introduction to nanobiology, bionanotechnology, nanobiochemistry, molecular nanotechnology, Nanosomes, Benefits of molecular nanotechnology).

Unit V Nanotechnology in biomedical and Life Sciences

Introduction, nanomedicine, drug delivery, nanocapsule; nanorobots; nanopharmacology, other nanotechnology products and applications in other areas. Research & development and career opportunities in nanotechnology (Indian and global perspective).

Texts/References:

1. "Nanotechnology-principaes and applications" by S.K. Kulkarni, Capital pub. Com.
2. "Nanotechnology: A gentle introduction to the next big" by Mark and Daniel Ratner, person low price.
3. "Nano: The Essentials" by T.Pradeep. Tata McGraw Hill, New Delhi (2007)
4. "Introduction to Nanotechnology" by Charles P Poole Jr and Frank J Ownes, John Wiley Sons, Inc(2003)
5. "Nanocomposite Science and Technology" by Pulickel m.Ajayan, Linda S.Schadler, PaulV.Braun, Wiley – VCH Verlag, weiheim (2003)
6. "Nanotechnology: Basic sciences and emerging technologies" by Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkar Raguse, Overseas Press (2005).
7. "Instrumental Methods of Analysis" by Willard, 2000.
8. "Instrumental Methods for Chemical Analysis" by Ewing. Etal 2000.
9. "Handbook of nanotechnology" by Bhushan
10. "Nanostructures & Nano Materials" by Ghuzang Cao.
11. "Nanoscale Technology in Biological Systems" by Cooper, Springer Verlag
12. "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" by Guozhong Cao
13. "Surface Science : Foundations of Catalysis and Nanoscience" by Kurt W. Kolasinski

14. "Self-Assembled Nanostructures" by G. Carotenuto
15. Integrated Chemical Systems : A Chemical Approach to Nanotechnology" (Baker Lecture Series) by Allen J. Bard

MBT-315B: Nanotechnology (Credits 4)

1. Nanotechnology –Introduction, Concepts and origin
Introduction and definition of nanotechnology, importance and role of nanoscale science and technology in the current context-pros and cons; history and development of nanotechnology –contribution of scientists and technologists. [4L]

2. Latest developments and future of nanotechnology: Intoduction, Silicon based technology and molecular manufacturing; introduction to nanotechnology applications in diverse fields (e.g. nanobiotechnology, nanomaterials); nanotech device developments (e.g. nanotubes, biosensors, solar cells). [6 L]

3. Properties of nanomaterials: Introduction, nanochemistry including self-assembly of materials; nanoparticles, carbon nanotubes, nanocomposites; synthesis and characterization of such materials [8 L]

4. Nanobiology: Introduction to nanobiology, bionanotechnology, nanobiochemistry, molecular nanotechnology, Nanosomes, Benefits of molecular nanotechnology). [10 L]

5.Nanotechnology in biomedical and Life Sciences: Introduction, nanomedicine, drug delivery, nanocapsule; nanorobots; nanopharmacology, other nanotechnology products and applications in other areas. [10L]

6. Research & development and career opportunities in nanotechnology (Indian and global perspective). [4 L]

Text book:
1) "Nanotechnology-principaes and applications" by S.K. Kulkarni, Capital pub. Com.
2) "Nanotechnology: A gentle introduction to the next big" by Mark and Daniel Ratner, person low price.

Reference book:

1) "Nano: The Essentials" by T.Pradeep. Tata McGraw Hill, New Delhi (2007)
2) "Introduction to Nanotechnology" by Charles P Poole Jr and Frank J Ownes, John Wiley Sons, Inc(2003)
3) "Nanocomposite Science and Technology" by Pulickel m.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley – VCH Verlag, weiheim (2003)
4) "Nanotechnology: Basic sciences and emerging technologies" by Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkar Raguse, Overseas Press (2005).
5) "Instrumental Methods of Analysis" by Willard, 2000.
6) "Instrumental Methods for Chemical Analysis" by Ewing. Etal 2000.
7) "Handbook of nanotechnology" by Bhushan
8) "Nanostructures & Nano Materials" by Ghuzang Cao.
9) "Nanoscale Technology in Biological Systems" by Cooper, Springer Verlag
10) "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" by Guozhong Cao

11) "Surface Science : Foundations of Catalysis and Nanoscience" by Kurt W. Kolasinski
12) "Self-Assembled Nanostructures" by G. Carotenuto
13) Integrated Chemical Systems : A Chemical Approach to Nanotechnology" (Baker Lecture
Series) by Allen J. Bard

MBT-315C: Modeling and simulation in bioprocesses (Credit 4)

Unit I Approach to Modeling

Significance of modeling and simulation, kinetic models on different approaches; deterministicand stochastic, structured and unstructured, segregated and unsegregated; examples of each. Compartmental models (two and four); product formation model; genetically structured models, modeling of extra cellular enzyme production.

Unit II Modeling of Bioprocess

Modeling of continuous sterilization of medium; modeling of activated sludge process with a control system; model for anaerobic digestion, model for SCP production form spent sulfite liquor. Models for external mass transfer, internal diffusion and reaction within biocatalysts, model for antibiotic formation; modeling of therapeutic protein production with recombinant cells.

Unit III Simulation techniques (Software)

continuous system simulators (CSMP, INT, LEANS, MIDAS, MIMIC);dynamic process simulators (DYFLO, DYNSIS, PRODYC, REMUS); steady state material and energy balance programs(PACER, FLOWTRAN, CHESS);some aspects of INT and DYFLO programs; General arrangement of main program using INT subroutines.

Unit IV Simulation techniques (Numerical Methods)

Programs based on numerical methods like algebraic equations, Newton_Raphson method for algebraic convergence, interpolation, arbitrary function generation (FUN1, FUN2 subroutines). Programs based on solution of differential equations: Eular method for 1st and 2nd order integration, subroutines INT and INTI; Fourth order Runga –Kutta method: stability of numerical integration variable slip size method.

Unit V Case Studies

Case studies, Numerical problems.

Texts/References:

1. Bailey, J.E and D.F ollis , Biochemical Engineering fundamentals , 2nd ed. McGraw Hill Book Co. , 1988
2. Blanch, H.W and I.J. Dunn ,"Modeling and Simulation in Biochemical Engg" in advances in biochemical

engg. Vol-3 edited by T.K. Ghosh, A.Fiechler and N. Blakebrngh.
3. R.G.E Franks, " Modeling and Simulation in chemical engineering ", Wiley International 1972.
4. Kleinstreur ,C. and T. Powegha, " Modeling and Simulation of Bioreactor Process Dynamics " in Advances in Biochemical Engg./ Biotechnology , vol.30 , edited by A. Fiechler springer verlag , Berlin , Heidelberg,1984.

MBT-315C: Modeling and simulation in bioprocesses (Credit 4)

1) Significance of modeling and simulation, kinetic models on different approaches; deterministic and stochastic, structured and unstructured, segregated and unsegregated; examples of each class.

2) Compartmental models (two and four); product formation model; genetically structured models, modeling of extra cellular enzyme production. [5L]

3) Modeling of continuous sterilization of medium; modeling of activated sludge process with a control system; model for anaerobic digestion, model for SCP production form spent sulfite liquor. [5 L]

4) Models for external mass transfer, internal diffusion and reaction within biocatalysts, model for antibiotic formation; modeling of therapeutic protein production with recombinant cells. [5 L]

5) Simulation techniques; continuous system simulators (CSMP, INT, LEANS, MIDAS, MIMIC);dynamic process simulators (DYFLO, DYNSIS, PRODYC, REMUS); steady state material and energy balance programs(PACER, FLOWTRAN, CHESS);some aspects of INT and DYFLO programs; General arrangement of main program using INT subroutines. [5 L]

6) Programs based on numerical methods like algebraic equations, Newton_Raphson method for algebraic convergence, interpolation, arbitrary function generation (FUN1, FUN2 subroutines). [5L]

7) Programs based on solution of differential equations: Eular method for 1st and 2nd order integration, subroutines INT and INTI; Fourth order Runga –Kutta method: stability of numerical integration variable slip size method. [5 L]

References:

1. Bailey, J.E and D.F ollis , Biochemical Engineering fundamentals , 2nd ed. McGraw Hill Book Co. , 1988
2. Blanch, H.W and I.J. Dunn , "Modeling and Simulation in Biochemical Engg" in advances in biochemical engg. Vol-3 edited by T.K. Ghosh, A.Fiechler and N. Blakebrngh.
3. R.G.E Franks, " Modeling and Simulation in chemical engineering ", Wiley International 1972.
4. Kleinstreur ,C. and T. Powegha, " Modeling and Simulation of Bioreactor Process Dynamics " in Advances in Biochemical Engg./ Biotechnology , vol.30 , edited by A. Fiechler springer verlag , Berlin, Heidelberg,1984.

MBT-315D: Pharmaceutical Biotechnology (Credit 4)

MASTER OF TECHNOLOGY IN

Biotechnology

CURRICULUM & SYLLABUS

Unit I Introduction

History of pharmacy; The pharmaceutical industry & development of drugs; Economics and regulatory aspects; Quality management; GMP

Unit II Drug kinetics and biopharmaceutics

Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process; Bioequivalence; Pharmacokinetics.

Unit III Principles of drug manufacture

Liquid dosage forms – solutions, suspensions and emulsions; Topical applications – ointments, creams, suppositories; Solid dosage forms – powders, granules, capsules, tablets, coating of tablets; Aerosols; Preservation; Packing techniques

Unit IV Advances in drug delivery

Advanced drug delivery systems – controlled release; Transdermals, Liposomes and drug targeting

Unit V Biopharmaceuticals

Understanding principles of pharmacology, pharmacodynamics; Study of a few classes of therapeutics like Recombinant therapeutics, Monoclonal Antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

Texts/References:

1. Lachman, L. et al., The Theory and Practice of Industrial Pharmacy, 3rd Edition, Varghese Publishing House, 1987.
2. Aulton, M.E. Pharmaceutics: The Science of Dosage form Design, 2nd Edition, Churchill Livingstons, 2002.
3. Ansel, H.C. etal., Pharmaceutical Dosage Forms and Drug Delivery Systems, 7th Edition, Lippincott Williams, Wilkins, 2002.
4. Nogardy Thomas, Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd Edition, OUP, 2005.
5. Rawlins, E.A., Bentley's Textbook of Pharmaceutics, 8th Edition, Baillire, Tindall, 2005.
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8. Tripathi, K.D. "Essentials of Medical Pharmacology", 6th Edition, Jaypee Bros. Med. Publishers, 2008.

MBT-316A: Biosafety, Ethics and IPR (Credit 4) Unit I Concept and implications

of Bioethics

Introduction to ethics and bioethics, roots of honours and integrity in science, The responsible conducts of biotechnological research, Research with human beings; societal obligation of a biotechnologist. Research with human beings; societal obligation of a biotechnologist: Introduction to Biosafety, Classification and Description of Biosafety Levels, Design of Clean rooms and and Biosafety Labs,

Biosafety regulations to protect Nature , Growers and Consumers.

Unit II Overview of general principles of Law
Jurisprudential, definition and concept of property rights, duties and their correlations,
History and evaluation of IPR – like patent design and copy right, Introduction to the need of intellectual Property rights, Distinction among the various forms of IPR, IPR in India and Abroad., Requirements of a patentable invention like novelty, inventive step, Prior art and state of art.

Unit III International and national interest of Biosafety
Development and consequences on usage of GMOs: Risk for animal/human/agriculture
owing to GMOs, risk of environment owing to GMOs, Introduction and need for Ethics, Ethical Issues involving GMOs, Ethical Issues in India and Abroad. Regulations on ethical principles in biomedical/ biotechnological practice: The Nuremberg code, declaration of Helsinki, The Belmont report, co-operational guidelines, WHO, guidelines of DBT, Guidelines of an informed consent, Rights/ protection, infringement or violation, Remedies against infringement, civil and criminal.

Unit IV Concepts of Patenting: Indian patent act 1970
TRIPS major changes in Indian patent system, post-TRIPS effects, Contents of patent
specification and procedure for patents, Obtaining patents, geographical indication, WTO, Detailed information on patenting biological products: Biodiversity Budapest, Appropriate Case Studies Biotechnology/ biomedicine application, Ethical consideration; ethics and the natural world, Environmental ethics (protecting public health and environment, Genetically

modified foods – the ethical and social issue. Ethical issues in genetic engg, Biomedical science, eugenic enhancement, eugenic genetic engg. Genetic information – use and abuse, Patenting human genes, Ethical and policy issue.

Unit V Ethics in cloning, genetic, Testing and screening
Human gene therapy and genetic modification, Ethical and public consideration, Legal
implication of somatic cell, gene therapy- germ line gene therapy. Ethics in Research design, Plagiarism in Research and publication implication --South Korea stem cell model. Copyright piracy and current global trends China model of infringement cases Trademark, Business mark, service mark and geographical indication national and international case studies. IPR and Business ethics case studies in at least five majorbiopharmaceutical companies.(Monsanto, Millennium, Genezyme, TGN biotech, Sciona etc).

Texts/References:
1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co.
Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information
Solution Pvt. Ltd., 2007
3. T. M. Murray and m.J.Mehlman. Encyclopedia of ethical, Legal and Policy Issues in Biotechnology. John Wiley & Sons 2000.
Important Links: http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in

MASTER OF TECHNOLOGY IN

Biotechnology

CURRICULUM & SYLLABUS

www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section

MBT-316A: Biosafety, Ethics and IPR (Credit 4)

Concept and implications of Bioethics (L 6)
Introduction to ethics and bioethics, roots of honours and integrity in science, The responsible conducts of biotechnological research, Research with human beings; societal obligation of a biotechnologist. Research with human beings; societal obligation of a biotechnologist: Introduction to Biosafety, Classification and Description of Biosafety Levels, Design of Clean rooms and and Biosafety Labs, Biosafety regulations to protect Nature , Growers and Consumers

Overview of general principles of Law (L 6)
Jurisprudential, definition and concept of property rights, duties and their correlations,
History and evaluation of IPR – like patent design and copy right, Introduction to the need of intellectual Property rights, Distinction among the various forms of IPR, IPR in India and Abroad., Requirements of a patentable invention like novelty, inventive step, Prior art and state of art.

Unit III International and national interest of Biosafety (L-8)
Development and consequences on usage of GMOs: Risk for animal/human/agriculture owing to GMOs, risk of environment owing to GMOs, Introduction and need for Ethics, Ethical Issues involving GMOs, Ethical Issues in India and Abroad. Regulations on ethical principles in biomedical/ biotechnological practice: The Nuremberg code, declaration of Helsinki, The Belmont report, co-operational guidelines, WHO, guidelines of DBT, Guidelines of an informed consent, Rights/ protection, infringement or violation, Remedies against infringement, civil and criminal,

Concepts of Patenting: Indian patent act 1970 (L-10)
TRIPS major changes in Indian patent system, post-TRIPS effects, Contents of patent specification and procedure for patents, Obtaining patents, geographical indication, WTO, Detailed information on patenting biological products: Biodiversity Budapest, Appropriate Case Studies Biotechnology/ biomedicine application, Ethical consideration; ethics and the natural world, Environmental ethics (protecting public health and environment, Genetically modified foods – the ethical and social issue. Ethical issues in genetic engg, Biomedical science, eugenic enhancement, eugenic genetic engg. Genetic information – use and abuse, Patenting human genes, Ethical and policy issue

Ethics in cloning, genetic, Testing and screening (L –10)
Human gene therapy and genetic modification, Ethical and public consideration, Legal implication of somatic cell, gene therapy- germ line gene therapy. Ethics in Research design, Plagiarism in Research and publication implication --South Korea stem cell model. Copyright piracy and current global trends China model of infringement cases Trademark, Business mark, service mark and geographical indication national and international case studies. IPR and Business ethics case studies in at least five major biopharmaceutical companies.(Monsanto, Millennium, Genezyme, TGN biotech, Sciona etc)

Texts/References:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
3.T. M. Murray and m.J.Mehlman. Encyclopedia of ethical, Legal and Policy Issues in Biotechnology. John Wiley & Sons 2000. **Important**

Links:

http://www.w3.org/IPR/ http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in
www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section

MBT-316B: Environmental Biotechnology (Credit 4) Unit I Introduction

Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes

Unit II Pollution

Enviromental pollution; Source of pollution; Air, water as a source of natural resource; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green house effect; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals

Unit III Control, remediation and management

Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioaugmentation; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries

Unit IV Alternate source of energy

Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuels; Bioethanol and biohydrogen; Solid waste management

Unit V Environment and health in respect to genetics

Gene and environment; Effect of carbon and other nanoparticles upon health; Gene mutation; Genetic testing; Genetic sensors; Environmental pollution and children; Human biomonitoring

Texts/References:

1. MetCalfe and Eddy Inc., Wastewater Engineering: Treatment, Disposal and Reuse", 4th Edition, McGraw Hill Book Co., 2003
2. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering, 4th Edition, McGraw Hill Book Co., 2006.
3. R.M.Maier, I.L.Pepper and C.P.Gerba, Elsevier, Environmental Microbiology: A Laboratory Manual, 2nd Edition, Academic Press, 2004.
4. B.C.Bhattacharyya and R.Banerjee, Environmental Biotechnology, Oxford University Press
5. I.S.Thakur, Environmental Biotechnology: Basic Concepts and Applications, I.K.International.

MBT-316B: Environmental Biotechnology (Credit 4)

Unit I Introduction

Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes

Unit II Pollution

Enviromental pollution; Source of pollution; Air, water as a source of natural resource; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green house effect; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals

Unit III Control, remediation and management

Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes; Anaerobic filters; Anaerobic sludge blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, and GE organisms; Plasmid borne metabolic treatment; Bioaugmentation; Bioremediation of contaminated soils and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries

Unit IV Alternate source of energy

Biomass as source of energy; Bioreactors; Rural biotechnology; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuels; Bioethanol and biohydrogen; Solid waste management

Unit V Environment and health in respect to genetics

Gene and environment; Effect of carbon and other nanoparticles upon health; Gene mutation; Genetic testing; Genetic sensors; Environmental pollution and children; Human biomonitoring

Texts/References:

1. MetCalfe and Eddy Inc., Wastewater Engineering: Treatment, Disposal and Reuse", 4th Edition, McGraw Hill Book Co., 2003
2. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering, 4th Edition, McGraw Hill Book Co., 2006.
3. R.M.Maier, I.L.Pepper and C.P.Gerba, Elsevier, Environmental Microbiology: A Laboratory Manual, 2nd Edition, Academic Press, 2004.
4. B.C.Bhattacharyya and R.Banerjee, Environmental Biotechnology, Oxford University Press
5. I.S.Thakur, Environmental Biotechnology: Basic Concepts and Applications, I.K.International.

MBT-316C: Bio-pharmaceuticals (Credit 4)

Unit I Drug development, Manufacturing, Formulation and Drug delivery processes Introduction, Drug discovery and development; steps of drug discovery; Patenting, Drug manufacturing processes, biochemical Product formulation processes; Delivery of biopharmaceuticals as drugs: Parenteral delivery systems, Oral delivery systems, Pulmonary delivery, Nasal delivery, Ophthalmic delivery, transmucosal and transdermal delivery systems. Current status and future development trends of biopharmaceuticals.

Unit II Cytokines-Interferon family as biopharmaceuticals
Introduction, Cytokines, cytokine receptors and Interferons; Types of interferons and function; signal transduction in interferon's, JAK-STAT pathway in interferon's and biological effects, eIF-2a protein kinase system, Interferon biotechnology, production and medical uses/applications of IFN-α, IFN-β, Medical a IFN-γ, Additional isolated interferons.

Unit III Interleukins, Tumour necrosis factor and Growth factor family as biopharmaceutical
Introduction, Interleukin: Interleukin-2 (IL-2), Interleukin-1 (IL-1), Other Interleukins; Tumour necrosis factors (TNFs); Growth factors: Insulin-like growth factors (IGFs), Epidermal growth factor (EGF), Platelet-derived growth factor (PDGF), Fibroblast growth factors (FGFs), Transforming growth factors (TGFs), Neurotrophic factors, neurotrophins, Ciliary neurotrophic factor and glial cell line-derived neurotrophic factor, Neurotrophic factors and neurodegenerative diseases.

Unit IV Hormones, thrombolytic agents, vaccines, and nucleic acids as biopharmaceuticals
Introduction, Therapeutic protein hormones; proteins as thrombolytic agents, Vaccines: for Hepatitis B and tetanus immunoglobulin, Snake and spider antivenins for AIDS and Cancer; Peptide vaccines; AIDS and Cancer; monoclonal antibodies for Cardiovascular disease, Infectious diseases, Autoimmune disease, Transplantation and Anti-tumour antibodies; Nucleic acids as a therapeutic biopharmaceutical.

Unit V Blood factors, Haemapoietic growth factors and Therapeutic enzymes as biopharmaceuticals
Introduction, Blood and Blood substitutes; Haemostasis: coagulation pathway, Clotting disorders, Production of factor VIII, Factors IX, VIIa and XIII; Anticoagulants, Haemopoietic growth factors: Granulocyte colony stimulating factor (G-CSF), Macrophage colony- stimulating factor (M-CSF) Granulocyte-macrophage colony stimulating factor (GM-CSF), Leukaemia inhibitory factor (LIF), Erythropoietin (EPO), Thrombopoietin; Enzymes of therapeutic value: Asparaginase, Dnase, Glucocerebrosidase, a-Galactosidase and urate oxidase, Superoxide dismutase, Lactase.

References
1) "Biopharmaceuticals Biochemistry and biotechnology" (2nd Edition) by Gary Walsh, Pub: Wiley Reference books:
2) "Drug Delivery and Targeting" by A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
3) "Pharmaceutical Biotechnology" by S. P. Vyas, V. Dixit, CBS Publishers

4) "Pharmaceutical Biotechnology" by Sambhamurthy & Kar , NewAge Publishers
5)" Monoclonal antibodies: applications in clinical oncology" by Epenetos A.A.(ed), Chapman and Hall Medical, London
6) Biopharmaceutics and Pharmacokinetics by V.Venkatesharalu , Pharma Books Syndicate

MBT-316C: Bio-pharmaceuticals (Credit 4)

Unit I Drug development, Manufacturing, Formulation and Drug delivery processes:(7L)
Introduction, Drug discovery and development; steps of drug discovery; Patenting, Drug manufacturing processes, biochemical Product formulation processes; Delivery of biopharmaceuticals as drugs: Parenteral delivery systems, Oral delivery systems, Pulmonary delivery, Nasal delivery, Ophthalmic delivery, transmucosal and transdermal delivery systems. Current status and future development trends of biopharmaceuticals.

Unit II Cytokines-Interferon family as biopharmaceuticals: (5L)
Introduction, Cytokines, cytokine receptors and Interferons; Types of interferons and function; signal transduction in interferon's, JAK-STAT pathway in interferon's and biological effects, eIF-2a protein kinase system, Interferon biotechnology, production and medical uses/applications of IFN-α, IFN-β, Medical a IFN-γ, Additional isolated interferons.

Unit III Interleukins, Tumour necrosis factor and Growth factor family as biopharmaceutical: (10L)
Introduction, Interleukin: Interleukin-2 (IL-2), Interleukin-1 (IL-1), Other Interleukins; Tumour necrosis factors (TNFs); Growth factors: Insulin-like growth factors (IGFs), Epidermal growth factor (EGF), Platelet-derived growth factor (PDGF), Fibroblast growth factors (FGFs),
Transforming growth factors (TGFs), Neurotrophic factors, neurotrophins, Ciliary

neurotrophic factor and glial cell line-derived neurotrophic factor, Neurotrophic factors and neurodegenerative diseases.

Unit IV Hormones, thrombolytic agents, vaccines, and nucleic acids as biopharmaceuticals: (10L)

Introduction, Therapeutic protein hormones; proteins as thrombolytic agents, Vaccines: for Hepatitis B and tetanus immunoglobulin, Snake and spider antivenins for AIDS and Cancer; Peptide vaccines; AIDS and Cancer; monoclonal antibodies for Cardiovascular disease, Infectious diseases, Autoimmune disease, Transplantation and Anti-tumour antibodies; Nucleic acids as a therapeutic biopharmaceutical.

Unit V Blood factors, Haemapoietic growth factors and Therapeutic enzymes as biopharmaceuticals: (10 L)

Introduction, Blood and Blood substitutes; Haemostasis: coagulation pathway, Clotting disorders, Production of factor VIII, Factors IX, VIIa and XIII; Anticoagulants, Haemopoietic growth factors: Granulocyte colony stimulating factor (G-CSF), Macrophage colony-stimulating factor (M-CSF) Granulocyte-macrophage colony stimulating factor (GM-

CSF), Leukaemia inhibitory factor (LIF), Erythropoietin (EPO), Thrombopoietin; Enzymes of therapeutic value: Asparaginase, Dnase, Glucocerebrosidase, a-Galactosidase and urate oxidase, Superoxide dismutase, Lactase.

Text Book:

1) “Biopharmaceuticals Biochemistry and biotechnology” (2nd Edition) by Gary Walsh, Pub: Wiley

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1) “Drug Delivery and Targeting” by A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
2) “Pharmaceutical Biotechnology” by S. P. Vyas, V. Dixit, CBS Publishers
3) “Pharmaceutical Biotechnology” by Sambhamurthy & Kar , NewAge Publishers
4)” Monoclonal antibodies: applications in clinical oncology” by Epenetos A.A.(ed), Chapman and Hall Medical, London
5) Biopharmaceutics and Pharmacokinetics by V.Venkatesharalu , Pharma Books Syndicate

MBT-316D: Advanced instrumentation in Biotechnology
(Credits 4)

Unit I High Performance Liquid chromatography

Basic principles, Instrumentation, quantification, reverse phase, Macromolecular separation,(gel filtration/ion exchange).

Unit II Luminescence in Biotechnology

Basic principle, instrumentation, measurement, chemoluminescence immunoassay, bioluminescence assay, molecular biological application of luminescence. Flow cytometry for Biotechnology, Tools---- High throughput flow cytometry---fluorescence activated cell sorter—application in biotechnology.

Unit III Chemical synthesis of peptides
Background, solid phase peptide synthesis, limitations.

Unit IV Microscopic techniques in biotechnology
Light microscopy, phase contrast, dark field, and fluorescence microscopy Application of confocal microscopy; Electron microscopy: Basic principles, instrumentation, Transmission Electron microscopy, Scanning electron Microscopy. Atomic force microscopy.

Unit V Proteomics for biotechnology
Capillary electrophoresis; Basic principles, instrumentation, application in biotechnology; Mass spectrometry in Protein and Proteomics; Basic principles of MALDI-Mass spectrometry; MALD – TOF Analyzer; Microarray Technology, Basic Principles, Slide printing.

Texts/References:
1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
6. Keith Van Holde, Chien and Ho. Principles of Physical Biochemistry 2nd Edition Pearson
7. J.R. Lakowicz; Principles of Fluorescence Spectroscopy (Springer)
8. Seperation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong
9. Physical Biochemistry: David Friefelder, 5th Ed, PHI
10. Guide to protein purification: Methods in enzymology, volume 182

MBT-316D: Advanced instrumentation in Biotechnology
(Credits 4)

Unit I High Performance Liquid chromatography ---- 5 Lectures
Basic principles, Instrumentation, quantification, reverse phase, Macromolecular separation,(gel filtration/ion exchange)

Unit II Luminescence Biotechnology--- 5Lectures
Basic principle, instrumentation, measurement, chemoluminescence immunoassay, bioluminescence assay, molecular biological application of luminescence.

Unit III Chemical Synthesis of Peptides--- 3Lectures
Background, solid phase peptide synthesis, limitations

Unit IV Microscopic Techniques in Biotechnology --- 10 Lectures
Light microscopy, phase contrast, dark field, and fluorescence microscopy Application of

confocal microscopy; Electron microscopy: Basic principles, instrumentation, Transmission Electron microscopy, Scanning electron; Microscopy. Atomic force microscopy.

Unit V Capillary Electrophoresis for Biotechnology…… 5 Lectures
Basic principles, instrumentation, application in biotechnology

Unit VI Flow Cytometry for Biotechnology…… 5 Lectures
Tools---- High throughput flow cytometry---fluorescence activated cell sorter--application in biotechnology
Unit VII Mass Spectrometry in Protein and Proteomics---- 5 Lectures
Basic principles of MALDI-Mass spectrometry MALD – TOF Analyzer

Unit VIII Microarray Technology ---- 4 Lectures
Basic Principles, Slide printing.